

CCMC compared velocity and density calculated by the Heliospheric Tomography model to the measure values at the ACE satellite position every 6 hours. This was done for six different 27-day periods during six different years covering 1998-2003. The periods were chosen so that the ACE data covered approximately 24 of 27 days. The results of the Heliospheric Tomography model were compared to two standard models to create a metric score. The first standard model used was a persistence model. In this case, the previous data point was used as a prediction. This data was at least 6 hours old. This metric was used to measure the ability of the Heliospheric Tomography model to do space weather predictions. The second standard model was a 27-day average for either the density or velocity. This metric was used to measure the ability of the Heliospheric Tomography model to get the trends in the data correct. The metric scores were scaled so that scores would be between 0 and 100 where a score above 50 meant that the Heliospheric Tomography model was doing better than the standard model.

For the density comparison, the Heliospheric Tomography model performed worse than the persistence model for all six periods. The Heliospheric Tomography model did perform better than the mean model for 2 of the 6 periods but on average did not perform better than the mean. For the velocity comparison, the Heliospheric Tomography model performed worse than both the persistence and mean models for all six periods.

As requested by the model developer, we also did a time average of 12 hours instead of 6 hours. This did not change the scores significantly. We also did some tests changing parameters of the code (as requested by the code developer) but this also did not change the scores significantly.

Author: Kristi Keller

Metric for density where the Heliospheric Tomography Model is compared to two different standard models:

Persistence Model uses the previous data point as an ACE prediction.

Mean Model uses the mean for 27 days as an ACE prediction.

A score above 50 indicates that the Heliospheric Tomography Model is doing better than the standard model.

| Density Metric | Period 1 | Period 2 | Period 3 | Period 4 | Period 5 | Period 6 | Average |
|-------------------|----------|----------|----------|----------|----------|----------|---------|
| Persistence Model | 32.7794 | 32.4028 | 36.1496 | 44.9440 | 41.8843 | 32.4906 | 36.8 |
| Mean Model | 37.8647 | 47.0213 | 40.7240 | 51.1760 | 48.9772 | 50.5344 | 46.0 |

Metric for velocity where the Heliospheric Tomography Model is compared to two different standard models:

Persistence Model uses the previous data point as an ACE prediction.

Mean Model uses the mean for 27 days as an ACE prediction.

A score above 50 indicates that the Heliospheric Tomography Model is doing better than the standard model.

| Velocity Metric | Period 1 | Period 2 | Period 3 | Period 4 | Period 5 | Period 6 | Average |
|-------------------|----------|----------|----------|----------|----------|----------|---------|
| Persistence Model | 4.28328 | 10.8902 | 8.13095 | 6.93370 | 11.2322 | 3.57669 | 7.5 |
| Mean Model | 24.7947 | 51.0216 | 32.1052 | 40.1103 | 20.5535 | 33.5759 | 33.7 |

For period 5, the Heliospheric Tomography model only covered 38% of the time.

- I. Determining time period for testing
 - A. A run for the Heliosphere Tomography Model covers 27 days during May through October.
 - B. Determine 27 day periods for which ACE plasma data covers approximately 24 out of 27 days during May through October.
 - C. One period is taken from each year starting in 1998 and ending in 2003.
- II. Preparation of ACE data
 - A. Hourly average data is downloaded from the ACE Science Center for density, bulk proton speed, and position of spacecraft in gse coordinates.
 - B. If either the density or velocity is flagged bad for a particular time step, that time step is eliminated.
 - C. The ACE data is then averaged for 6 hours. All 6 points are required. If one point is missing, the time step is eliminated.
- III. Running the Heliospheric Tomography Model
 - A. The ACE spacecraft position is averaged for 6 hours and converted to the coordinate system used by the model.
 - B. The model is run for the 27 day period using the CCMC web site to generate a run on request.
 - C. Velocity and density from Heliospheric Tomography model are interpolated onto the ACE satellite positions.
- IV. Calculation of Metric
 - A. The results from Heliospheric Model are interpolated onto the same time scale as the ACE data. The model results are within ± 10 minutes of the ACE data.
 - B. An error is calculated for each period using $D_i = \sqrt{(\sum |\Delta H_{\text{model}} - \Delta H_{\text{data}}|^2) / n_{\text{pts}}}$.
 - C. An error is calculated for the standard model using the same formula.
 - D. A skill score is calculated by $M_i = 1 - D_i / D_s$. This gives a score from $-\infty$ to 1 where 1 is a perfect score and anything over zero means that the tomography model is doing better than the standard model.
 - E. This score is scaled using $S_i = 50 * (2 M_i)$ so that the scores go from 0 to 100 where above 50 means that the tomography model is doing better than the standard models.
- V. Standard Models
 - A. Persistence model: The previous data is used as the prediction for the model. This is typically 6 hours old but may be older if there is a data gap.
 - B. Mean model: The density and velocity are averaged over the entire 27 day period and used as a prediction.